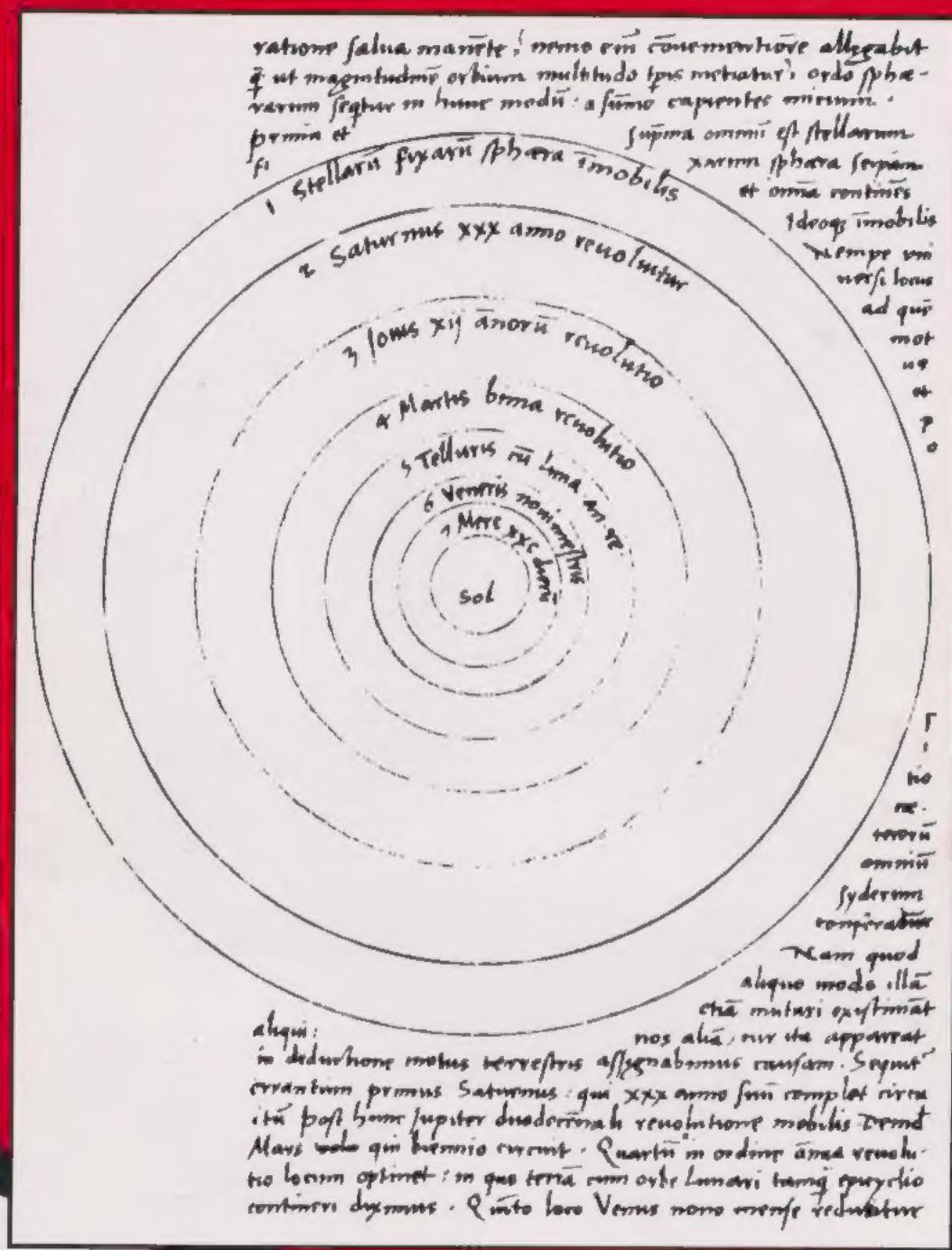




SCIENCE



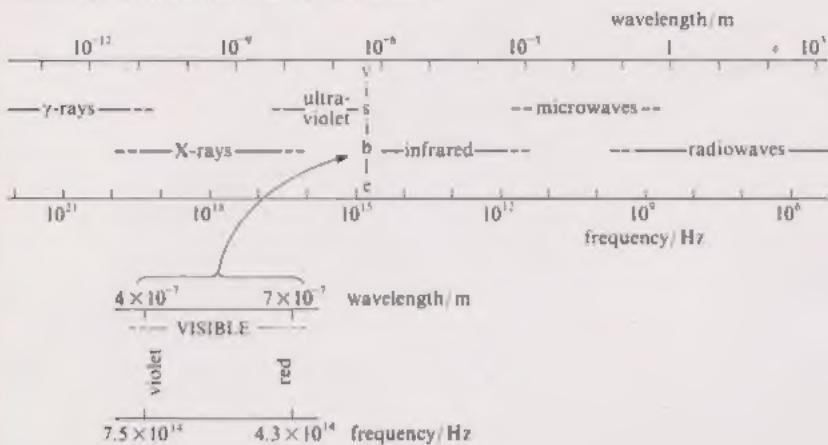
Unit 1
Science and the planet Earth

Unit 2
Measuring the Solar System

R. J. Collier

USEFUL INFORMATION FOR THE PHYSICS AND GENERAL SCIENCE UNITS

ELECTROMAGNETIC SPECTRUM



PHYSICAL CONSTANTS

Symbol	Quantity	Approximate value
G	gravitational constant	$6.672 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$
c	speed of light in a vacuum	$2.998 \times 10^8 \text{ ms}^{-1}$
h	Planck's constant	$6.626 \times 10^{-34} \text{ Js}$
e	magnitude of the charge of the electron	$1.602 \times 10^{-19} \text{ C}$
m_e	mass of the electron	$9.110 \times 10^{-31} \text{ kg}$
m_n	mass of the neutron	$1.675 \times 10^{-27} \text{ kg}$
m_p	mass of the proton	$1.673 \times 10^{-27} \text{ kg}$

USEFUL QUANTITIES AND CONVERSIONS

$\pi \approx 3.142$	Earth radius (equatorial) $\approx 6.38 \times 10^6 \text{ m}$
1 mile $\approx 1.609 \text{ km}$	circumference of the Earth (distance round the Equator) $\approx 4.01 \times 10^7 \text{ m}$
1 kilometre (km) $\approx 0.6214 \text{ mile}$	radius of the Moon $\approx 1.74 \times 10^6 \text{ m}$
1 inch = 2.54 cm	radius of the Sun $\approx 6.96 \times 10^8 \text{ m}$
1 centimetre (cm) $\approx 0.3937 \text{ inch}$	Earth-Sun distance (i.e. orbital radius of the Earth) $\approx 1.50 \times 10^{11} \text{ m}$
1 kilocalorie $\approx 4187 \text{ J}$	Earth-Moon distance (i.e. orbital radius of the Moon) $\approx 3.84 \times 10^8 \text{ m}$
1 electronvolt (eV) $\approx 1.602 \times 10^{-19} \text{ J}$	
1 radian $\approx 57.296 \text{ degrees}$	
1 degree $\approx 0.01745 \text{ radian}$	
1 GeV/c ² $\approx 1.783 \times 10^{-27} \text{ kg}$	

S102 UNITS

1	Science and the planet Earth	19	Life and evolution
2	Measuring the Solar System	20	Inheritance and cell division
3	Motion under gravity	21	Genes and evolution
4	Practical work in science	22	Biochemistry
5-6	Into the Earth: earthquakes, seismology and the Earth's magnetism	23	Physiology
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16	Chemical energetics	31	Quantum mechanics: atoms and nuclei
17-18	The chemistry of carbon compounds	32	The search for fundamental particles

SCIENCE

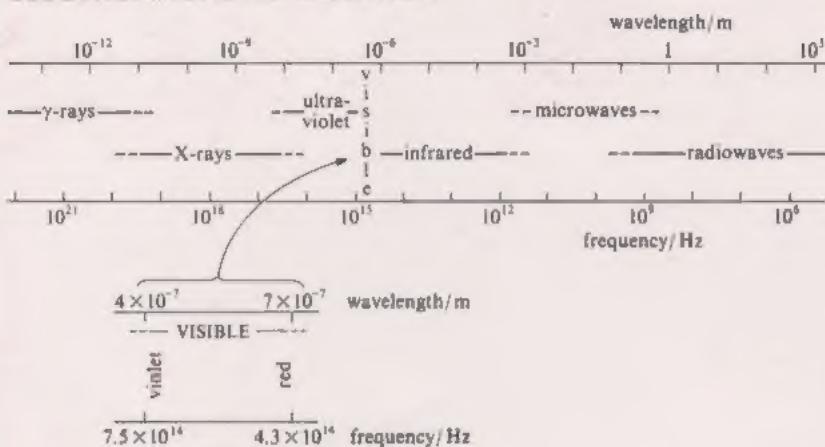


Unit 3
Motion under gravity

Unit 4
Practical work in science

USEFUL INFORMATION FOR THE PHYSICS AND GENERAL SCIENCE UNITS

ELECTROMAGNETIC SPECTRUM



PHYSICAL CONSTANTS

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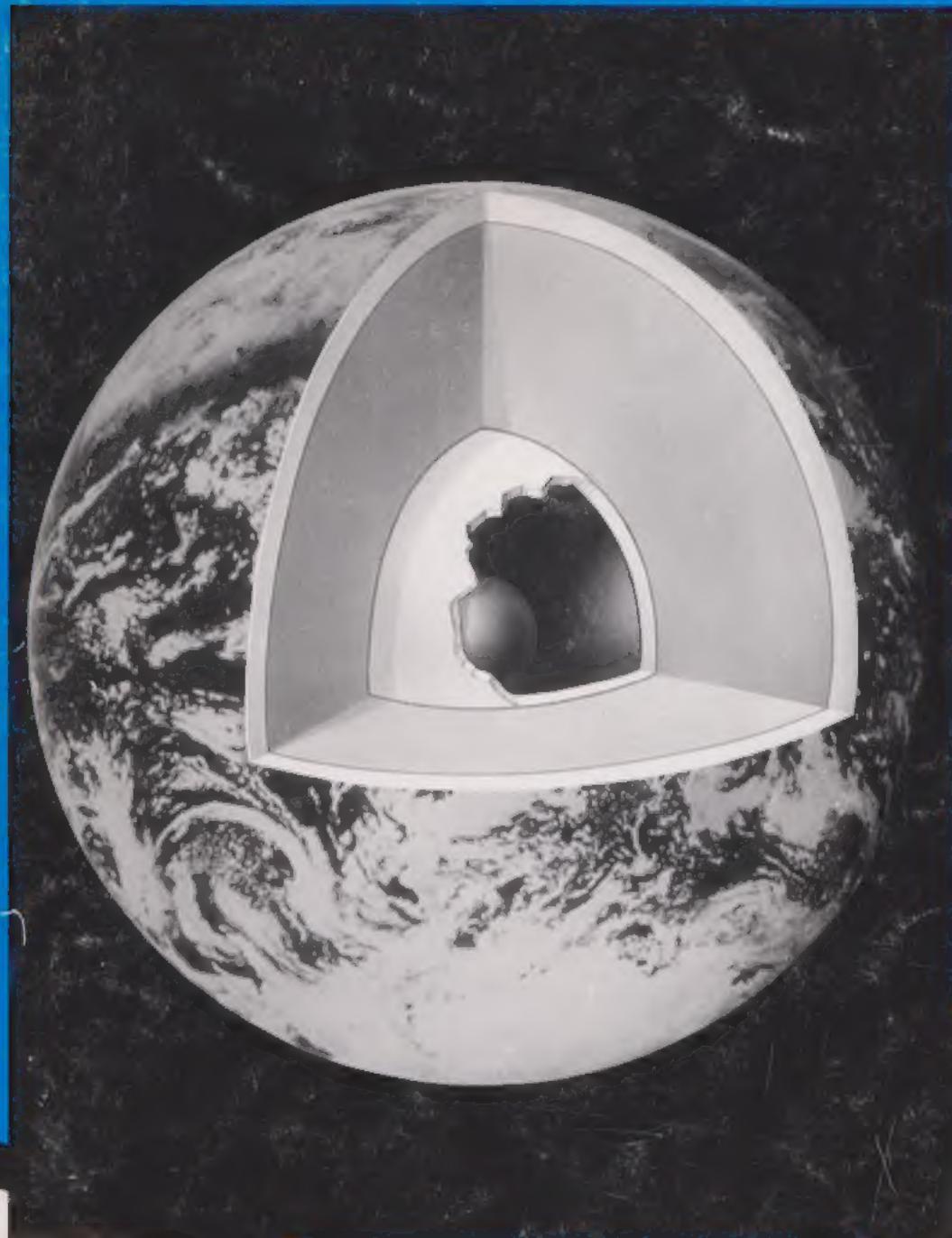
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17-18	The chemistry of carbon compounds	32	The search for fundamental particles

SCIENCE



Units 5-6

Into the Earth: earthquakes,
seismology and the Earth's magnetism

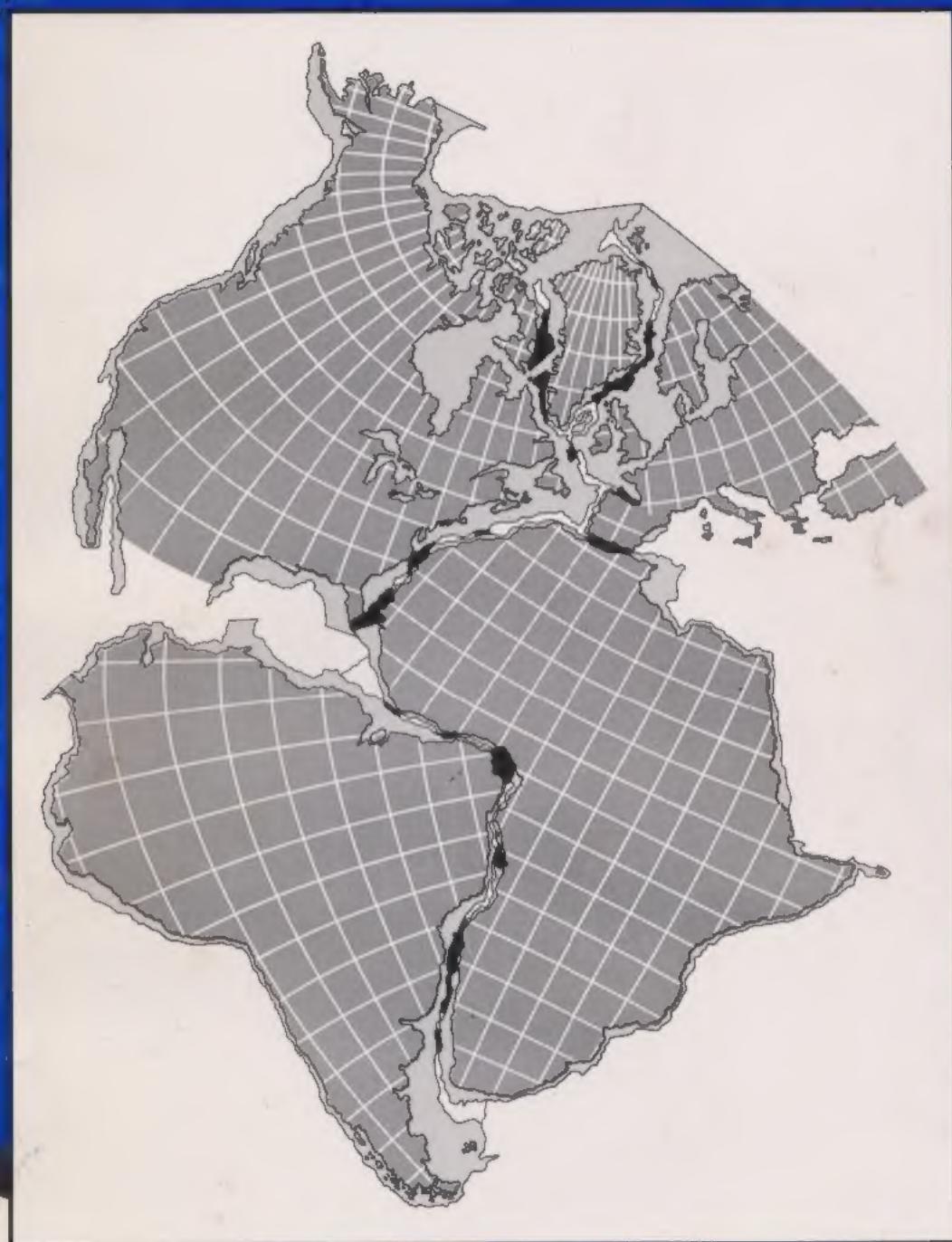
PROPERTIES OF THE EARTH'S INTERIOR

	depth/km	speed of P waves / km s ⁻¹	density/10 ³ kg m ⁻³	axial modulus/10 ¹¹ Nm ⁻²	percentage of total mass	possible nature of regions
LITHOSPHERE crust and top of mantle: rigid layer comprising the plates	CRUST continental: 25-90	6.0	2.7	1.0	0.7	granite (solid)
	oceanic: 6-11 Moho	7.0	3.0	1.5		basalt (solid)
ASTHENOSPHERE region of plastic deformation under loading beneath lithosphere which flows to permit isostatic compensation. Not synonymous with low-speed layer (LSL)	UPPER MANTLE LSL 400	8.0	3.3	2.1	68.0	peridotite (partially molten in LSL)
	TRANSITION ZONE 1050	8.2	3.4	2.3		peridotite (solid)
MANTLE LOWER MANTLE 2900	MANTLE	11.1	4.3	5.3	68.0	high density form of peridotite (solid)
		13.6	5.4	10.0		
CORE OUTER CORE 5155		8.1	9.9	6.5	31.3	iron+sulphur mixture (liquid)
		10.1	12.3	12.5		
INNER CORE 6370		11.2				iron+nickel mixture (solid)
			13.5	16.9		
		11.3				

S102 UNITS

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SCIENCE



Units 7-8
Plate tectonics:
a revolution in the Earth sciences

PROPERTIES OF THE EARTH'S INTERIOR

	depth/km	speed of P waves /km s ⁻¹	density /10 ³ kg m ⁻³	axial modulus/10 ¹¹ N m ⁻²	percentage of total mass	possible nature of regions
LITHOSPHERE crust and top of mantle; rigid layer comprising the plates	continental: 25-90	6.0	2.7	1.0	0.7	granite (solid)
ASTHENOSPHERE region of plastic deformation under loading beneath lithosphere which flows to permit isostatic compensation. Not synonymous with low-speed layer (LSL)	oceanic: 6-11	7.0	3.0	1.5		basalt (solid)
	Moho	8.0	3.3	2.1		peridotite (partially molten in LSL)
	LSL	8.2	3.4	2.3		
	400					
	TRANSITION ZONE					peridotite (solid)
	1050				68.0	
	LOWER MANTLE					high density form of peridotite (solid)
	2900	13.6	5.4	10.0		
		8.1	9.9	6.5		
	OUTER CORE					iron + sulphur mixture (liquid)
	5155	10.1	12.3	12.5	31.3	
		11.2				
	INNER CORE					iron + nickel mixture (solid)
	6370					
		11.3				

SIO₂ UNITS

- | | | | |
|-------|---|-------|--------------------------------------|
| 1 | Science and the planet Earth | 19 | Life and evolution |
| 2 | Measuring the Solar System | 20 | Inheritance and cell division |
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| 16 | Chemical energetics | 31 | Quantum mechanics: atoms and nuclei |
| 17–18 | The chemistry of carbon compounds | 32 | The search for fundamental particles |

SCIENCE

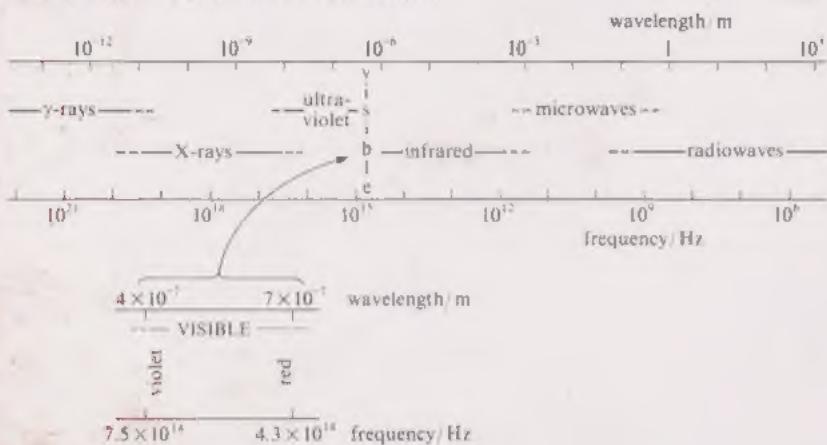


Unit 9
Energy

Unit 10
Modelling the behaviour of light

USEFUL INFORMATION FOR THE PHYSICS AND GENERAL SCIENCE UNITS

ELECTROMAGNETIC SPECTRUM



PHYSICAL CONSTANTS

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S102 UNITS

1 Science and the planet Earth	19	Life and evolution
2 Measuring the Solar System	20	Inheritance and cell division
3 Human under gravity	21	Genes and evolution
4 Practical work in science	22	Biochemistry
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17-18 The chemistry of carbon compounds	33	The search for fundamental particles

SCIENCE



Units 11-12
Atomic structure

THE PERIODIC TABLE

S102 UNITS

- | | | | |
|-------|---|-------|--------------------------------------|
| 1 | Science and the planet Earth | 19 | Life and evolution |
| 2 | Measuring the Solar System | 20 | Inheritance and cell division |
| 3 | Motion under gravity | 21 | Genes and evolution |
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| | | 24 | DNA: molecular aspects of genetics |
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| | | 26 | Biology reviewed |
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| 15 | Chemical equilibrium | 32 | The search for fundamental particles |
| 16 | Chemical energetics | | |
| 17-18 | The chemistry of carbon compounds | | |

SCIENCE



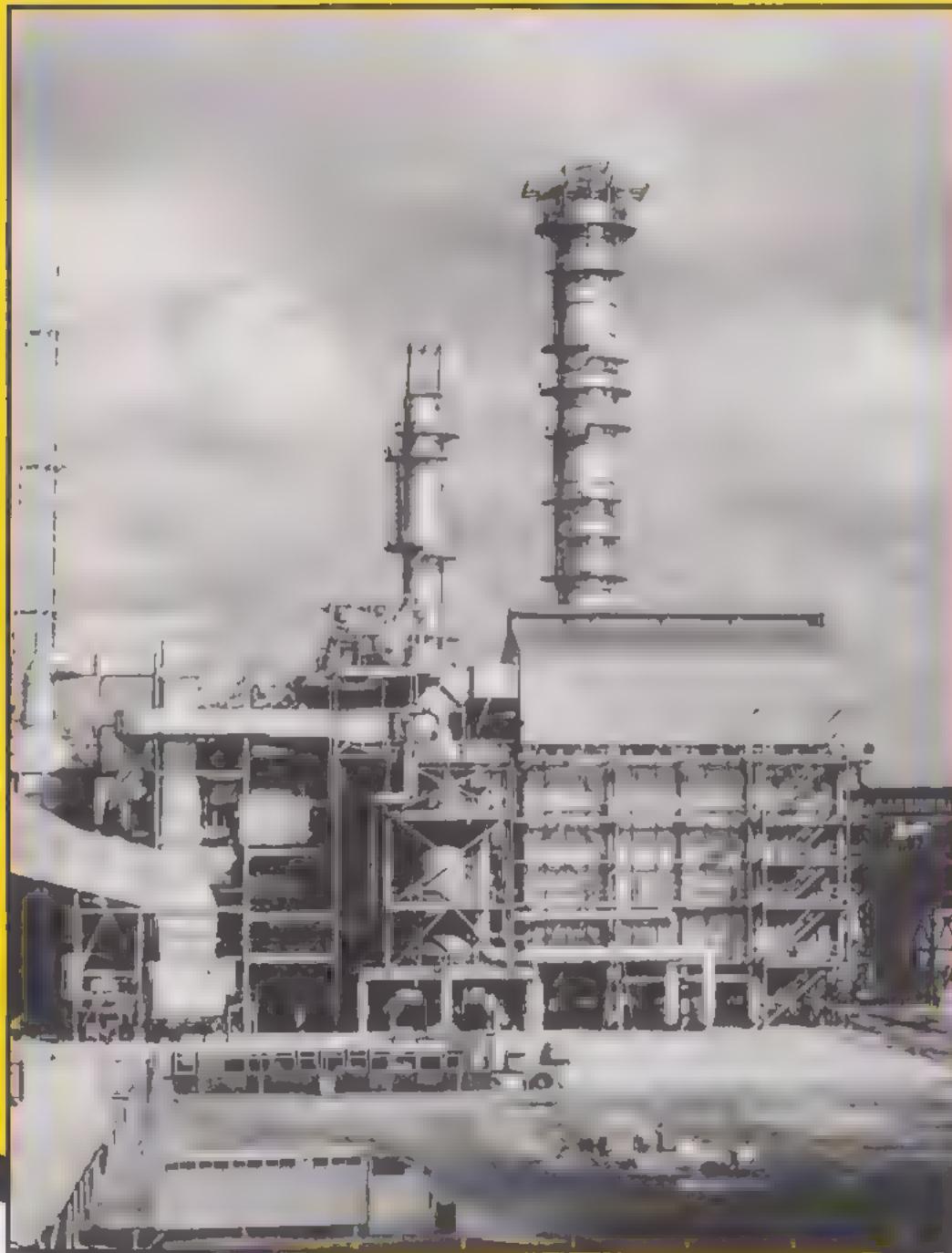
Units 13–14
Chemical reactions
and the Periodic Table

THE PERIODIC TABLE

S102 UNITS

1	Science and the planet Earth	19	Life and evolution
2	Measuring the Solar System	20	Inheritance and cell division
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15	Chemical equilibrium	3	Quantum mechanics: atoms and nuclei
16	Chemical energetics		
17-18	The chemistry of carbon compounds	32	The search for fundamental particles

SCIENCE



Unit 15
Chemical equilibrium

Unit 16
Chemical energetics

THE PERIODIC TABLE

I	II		III	IV	V	VI	VII	0
		H						He
1.	⁴ Be			B	C	N	O	F
2.	¹² Mg			Al	Si	S	Cl	Ar
3.	K Ca	Sc Ti V Cr Mn Fe Cu Ni Ca Zn Ga Ge As Se Br Kr						
4.	Rb Sr	Y Zr Nb Mo Tc Ru Rh Pd Ag Cd In Sn Sb Te I Xe						
5.	³⁵ Br Ba	[lanthanides] Lu Hf Ta W Re Os Ir Pt Au Hg Tl Pb Bi Po At Rn						
6.	⁸⁸ Fr Ra	[actinides] Lr						
		transition elements						
		typical elements						
		lanthanides						
		La Ce Pr Nd Pm Sm Eu Gd Tb Dy Ho Er Tm Yb						
		actinides						
		Ac Th Pa U Np Pu Am Cm Bk Cf Es Fm Md No						

S102 UNITS

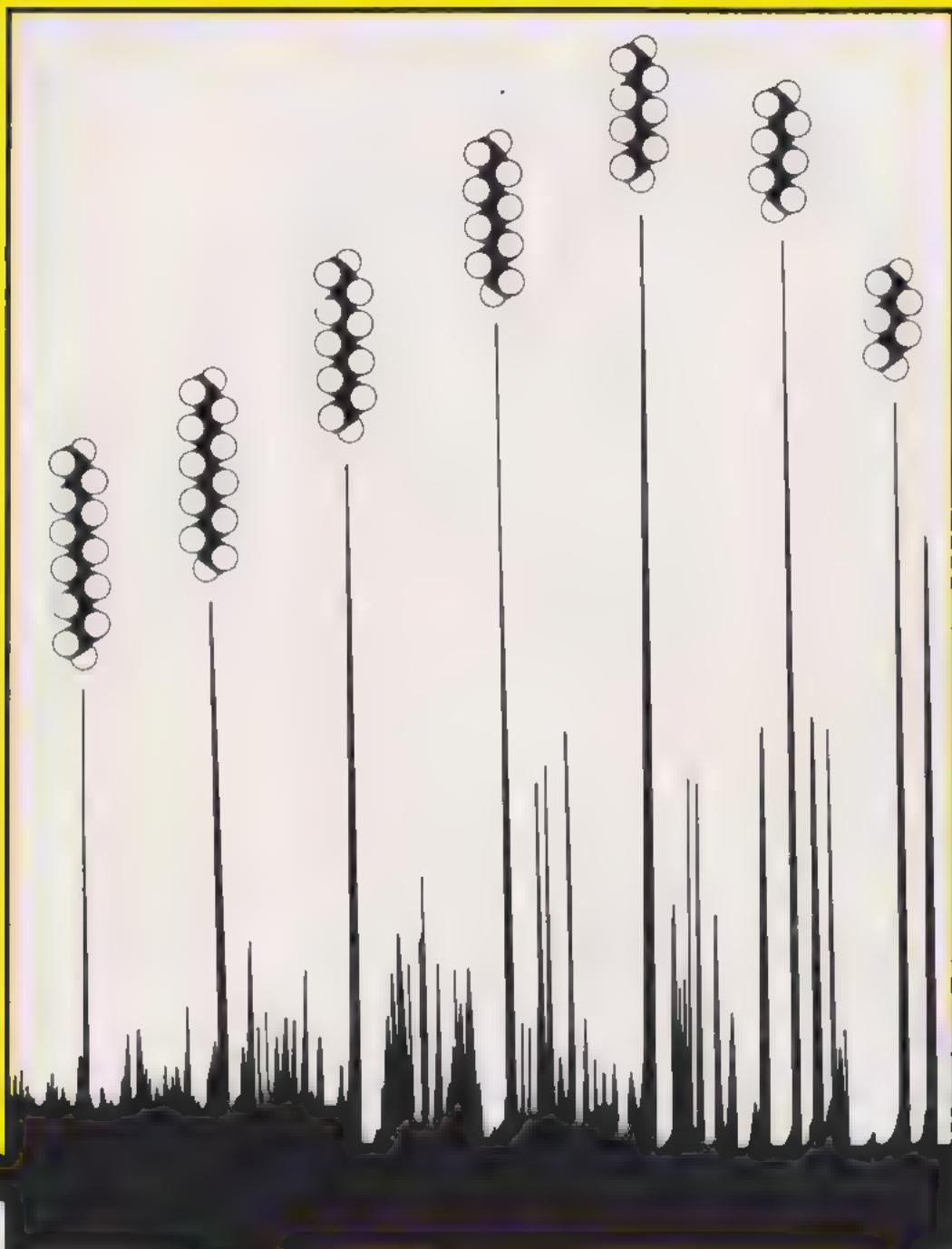
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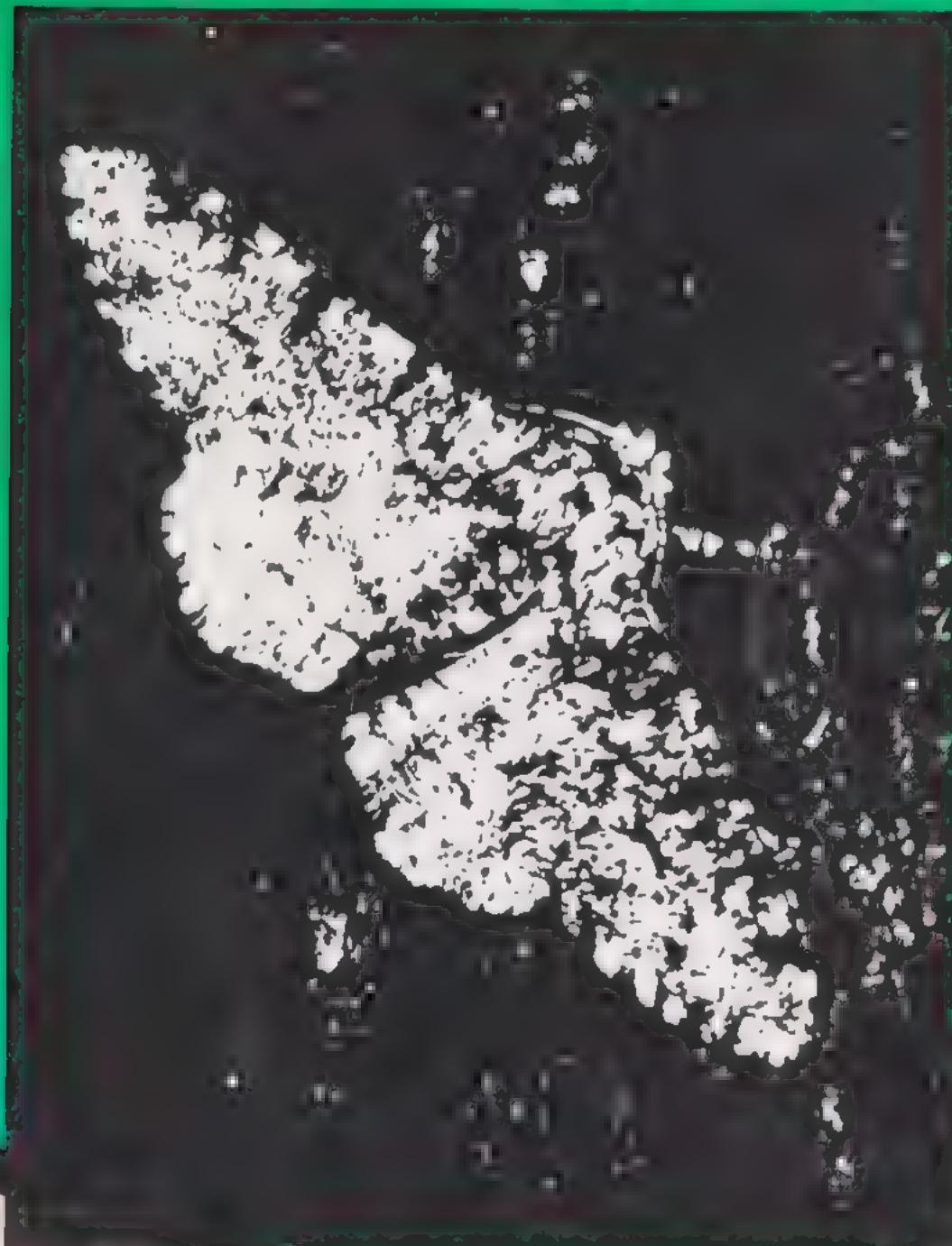
Units 17–18
The chemistry of
carbon compounds

THE PERIODIC TABLE

SIO2 UNITS

- | | | | |
|-------|---|-------|--------------------------------------|
| 1 | Science and the planet Earth | 19 | Life and evolution |
| 2 | Measuring the Solar System | 20 | Inheritance and cell division |
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| 4 | Practical work in science | 22 | Biochemistry |
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SCIENCE



Unit 19
Life and evolution

Unit 20
Inheritance and cell division

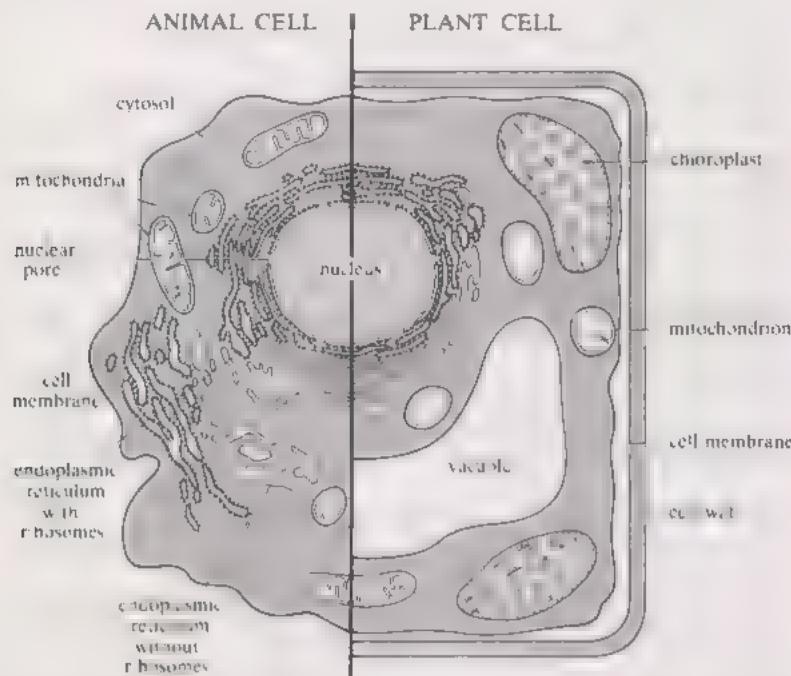
Unit 21
Genes and evolution

USEFUL INFORMATION FOR THE BIOLOGY UNITS: CHEMICALS, CELLS AND CLASSIFICATION

All cellular organisms contain these four biopolymers (made up of the monomers shown below)

Biopolymers:	polysaccharides	proteins	DNA	RNA
Monomers	monosaccharides	amino acids	deoxyribonucleotides	ribonucleotides

All eukaryotic organisms have cells of the following generalized structure



All living organisms can be divided into four kingdoms. The figures in brackets show the number of species (in thousands) in each subkingdom

Animals	Plants	Fungi	Prokaryotes
sponges (4)	eukaryotic algae (20)	slime moulds (0.5)	bacteria (1.6)
unicells (40)	true plants (330)	true fungi (100)	blue-green bacteria (formerly termed blue-green algae) (1.5)
multicells (1 000–2 000)			

S102 UNITS

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16	Chemical energies	31	Quantum mechanics: atoms and nuclei
17–18	The chemistry of carbon compounds	32	The search for fundamental particles

SCIENCE



**Unit 22
Biochemistry**

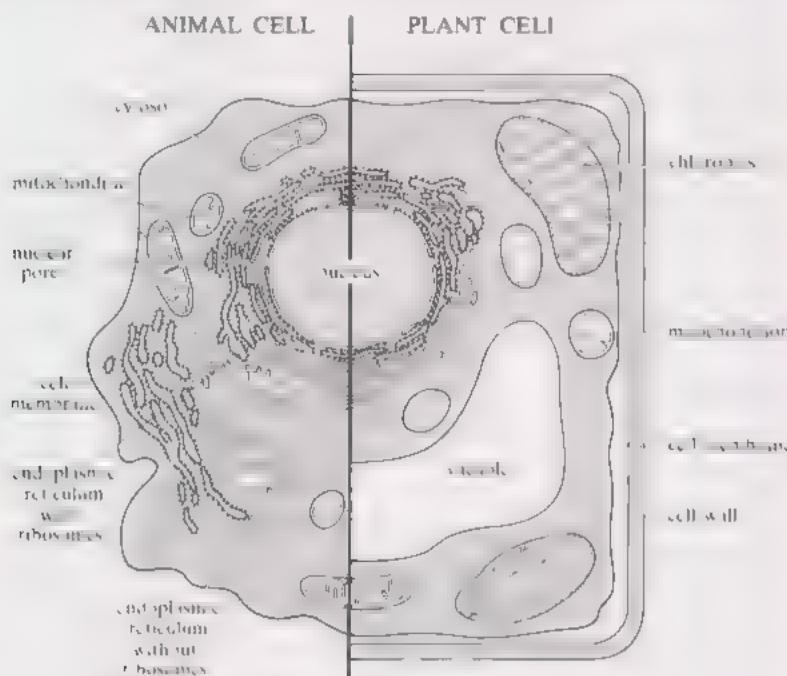
**Unit 23
Physiology**

USEFUL INFORMATION FOR THE BIOLOGY UNITS: CHEMICALS, CELLS AND CLASSIFICATION

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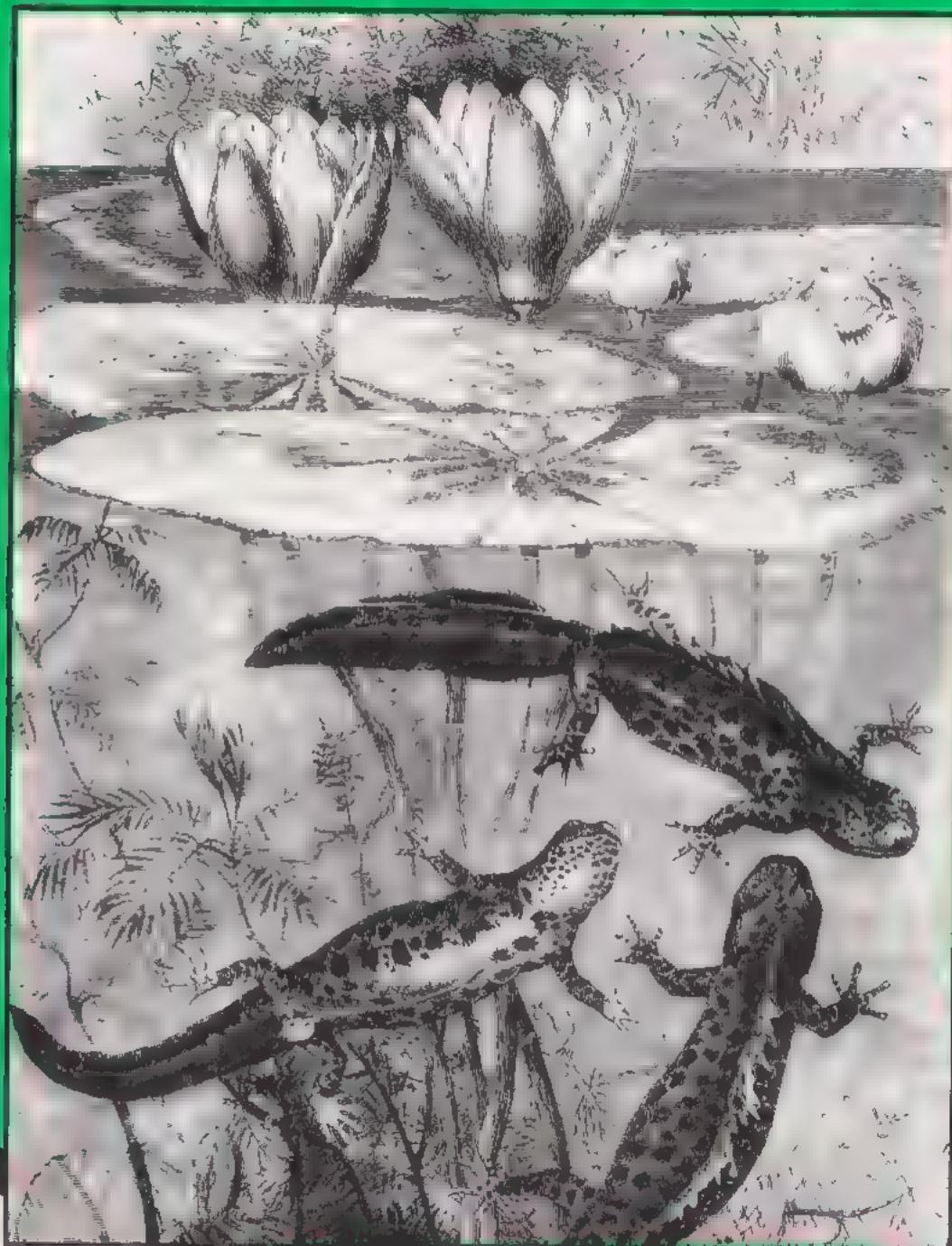
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multicells (1 000–2 000)			

S102 UNITS

1	Science and the planet Earth	9	Life and evolution
2	Measuring the Solar System	20	atterface and cell division
3	Motion under gravity	21	Genes and evolution
4	Practical work in science	22	Biochemistry
5–6	into the Earth: sea, lakes, seismology and the Earth's magnetism	23–24	Physiology
7–8	Plate tectonics: a revolution in the Earth sciences	25–26	DNA: molecular aspects of genetics
9	Energy	27	Ergonomics
10	Modelling the behaviour of light	28–29	Biology reviewed
11	Atomic structure	29	Earth materials and processes
12	Chemical reactions and the Periodic Table	30	Geological time and Earth history
13–14	Chemical equilibrium	31	Quantum mechanics: an introduction
15	Chemical energetics	32	Quantum mechanics: atoms and nuclei
16–18	The chemistry of carbon compounds		The search for fundamental particles

SCIENCE



Unit 24
DNA: molecular aspects of genetics

Unit 25
Ecology

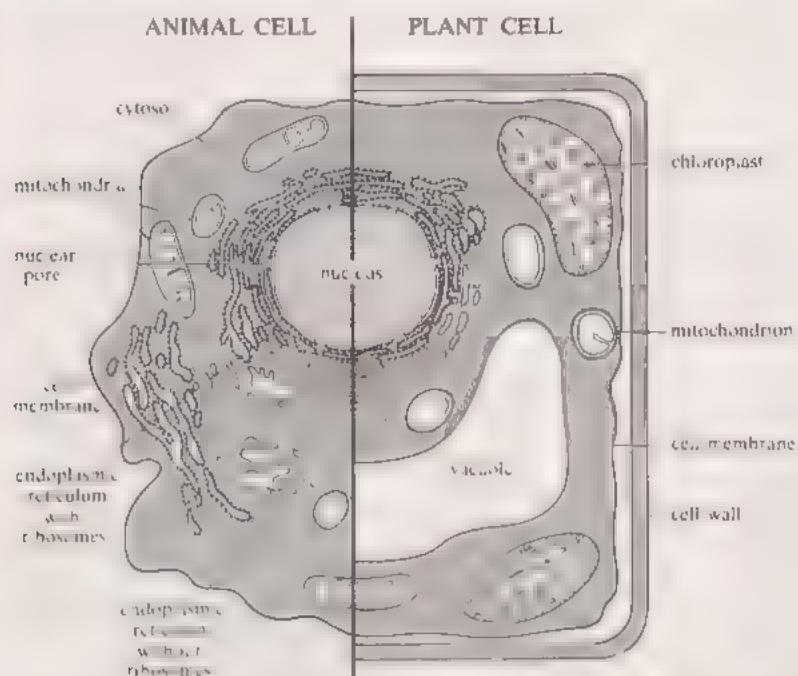
Unit 26
Biology reviewed

USEFUL INFORMATION FOR THE BIOLOGY UNITS: CHEMICALS, CELLS AND CLASSIFICATION

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17-18	The chemistry of carbon compounds		

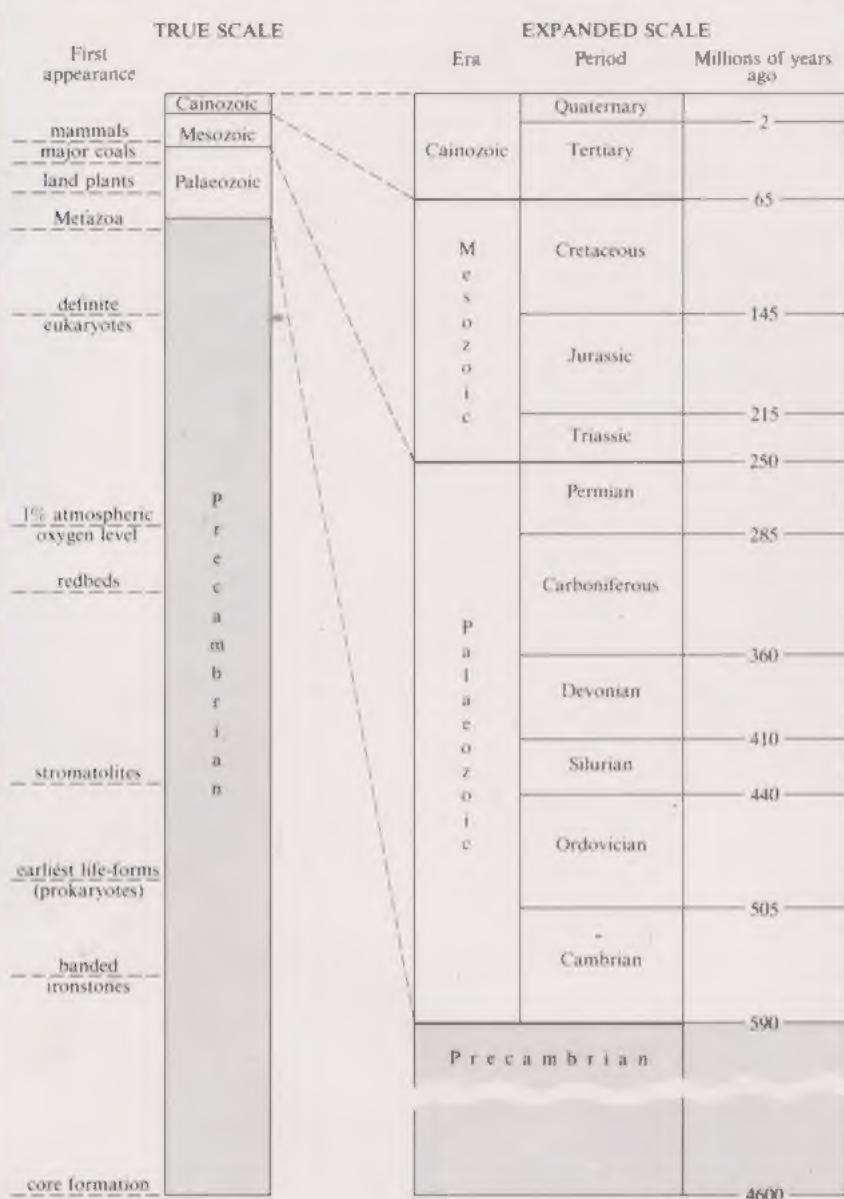
SCIENCE



Unit 27
Earth materials and processes

Units 28–29
Geological time and Earth history

EARTH HISTORY AND STRATIGRAPHIC COLUMN



S102 UNITS

1	Science and the planet Earth	19	Life and evolution
2	Measuring the Solar System	20	Inheritance and cell division
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4	Practical work in science	22	Biochemistry
5-6	Into the Earth: earthquakes, seismology and the Earth's magnetism	23	Physiology
7-8	Plate tectonics: a revolution in the Earth sciences	25	DNA: molecular aspects of genetics
9	Energy	26	Ecology
10	Modelling the behaviour of light	27	Biology reviewed
11-12	Atomic structure	28-29	Earth materials and processes
13-14	Chemical reactions and the Periodic Table	30	Geological time and Earth history
15	Chemical equilibrium	31	Quantum mechanics: an introduction
16	Chemical energetics	32	Quantum mechanics: atoms and nuclei
17-18	The chemistry of carbon compounds		The search for fundamental particles

SCIENCE



Unit 30

**Quantum mechanics:
an introduction**

Unit 31

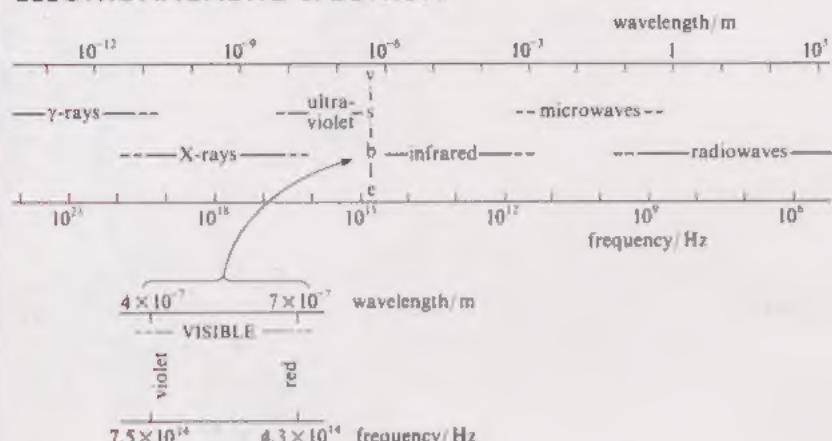
**Quantum mechanics:
atoms and nuclei**

Unit 32

The search for fundamental particles

USEFUL INFORMATION FOR THE PHYSICS AND GENERAL SCIENCE UNITS

ELECTROMAGNETIC SPECTRUM



PHYSICAL CONSTANTS

Symbol	Quantity	Approximate value
G	gravitational constant	$6.672 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$
c	speed of light in a vacuum	$2.998 \times 10^8 \text{ m s}^{-1}$
h	Planck's constant	$6.626 \times 10^{-34} \text{ J s}$
e	magnitude of the charge of the electron	$1.602 \times 10^{-19} \text{ C}$
m_e	mass of the electron	$9.110 \times 10^{-31} \text{ kg}$
m_n	mass of the neutron	$1.675 \times 10^{-27} \text{ kg}$
m_p	mass of the proton	$1.673 \times 10^{-27} \text{ kg}$

USEFUL QUANTITIES AND CONVERSIONS

$\pi \approx 3.142$	Earth radius (equatorial) $\approx 6.38 \times 10^6 \text{ m}$
1 mile $\approx 1.609 \text{ km}$	circumference of the Earth (distance round the Equator) $\approx 4.01 \times 10^7 \text{ m}$
1 kilometre (km) $\approx 0.6214 \text{ mile}$	radius of the Moon $\approx 1.74 \times 10^6 \text{ m}$
1 inch = 2.54 cm	radius of the Sun $\approx 6.96 \times 10^8 \text{ m}$
1 centimetre (cm) $\approx 0.3937 \text{ inch}$	Earth-Sun distance (i.e. orbital radius of the Earth) $\approx 1.50 \times 10^{11} \text{ m}$
1 kilocalorie $\approx 4187 \text{ J}$	Earth-Moon distance (i.e. orbital radius of the Moon) $\approx 3.84 \times 10^8 \text{ m}$
1 electronvolt (eV) $\approx 1.602 \times 10^{-19} \text{ J}$	
1 radian $\approx 57.296 \text{ degrees}$	
1 degree $\approx 0.01745 \text{ radian}$	
1 GeV/c ² $\approx 1.783 \times 10^{-27} \text{ kg}$	

S102 UNITS

1	Science and the planet Earth	19	Life and evolution
2	Measuring the Solar System	20	Inheritance and cell division
3	Motion under gravity	21	Genes and evolution
4	Practical work in science	22	Biochemistry
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